

The Dusty Plasma Experiment

Project Number: 95-19

Investigator: J.F. Spann/ES83

Purpose

The purpose of this experiment is to probe the charging mechanisms of dust grains by measuring the equilibrium charge under different space-like conditions.

Background

Small dust grains are prevalent throughout regions of space. Most often, these grains are electrically charged and are immersed in a field of charge particles such as electrons, protons, and ions. This agglomeration is called a dusty plasma. Dusty plasmas affect many regions of space including the Earth's upper atmosphere, the Earth's magnetosphere (that region in space where the Earth's magnetic field dominates the interactions of particles), the planetary rings around Saturn and Uranus, comet tails and interstellar regions of space. It is important to understand how dusty plasmas are formed and how they affect these regions. In order to do that, it is required that a full understanding of the charging mechanisms of the dust grains be achieved.

Approach

One of the unique aspects of this dusty plasma experiment is the use of an electrodynamic balance. Instead of using a group or cloud of dust grains in the experiment, a single dust grain will be studied at a time. In addition, the dust grain will be in a stable or equilibrium condition, not flying by so that it is probed only momentarily. Using this approach, repeated measurements can be made under varying conditions on the same dust grain. In this way, the microphysics of the charging mechanism will be probed. Light

scattering and viscous drag measurements will be employed to determine the dust grain size.

Accomplishments

This year has been a productive one. The electrodynamic balance has been assembled and tested. A liquid particle generator has been fabricated which has allowed us to trap particles with a size of ~2 microns in diameter. We are in the process of checking out the electron beam gun. A proposal was submitted in response to NRA 97-OSS-08 to study the IR extinction cross sections of interplanetary dusty particles which is based on the efforts expended thus far in this CDDF project. The dusty plasma experiment will be featured in an upcoming episode of the syndicated PBS show "Bill Nye the Science Guy." The crew of the show spent one morning filming the episode highlighting the likelihood of being able to study a real dust grain captured in a comet tail. A very interesting web page has been constructed and in use which describes the dusty plasma experimental work in ES83. The URL is:

<http://www.ssl.msfc.nasa.gov/ssl/pad/sppb/dusty/>



FIGURE 46.—Scattered light off of a 3-micron dust particle as seen on a video monitor.

Publications

One article describing the experiment and some preliminary results will be submitted for publication at the appropriate time. A presentation is planned for the Seventh Workshop on the Physics of Dusty Plasmas to be held in Boulder, CO, April 4–9, 1998.

Status of Investigation

Project approval—November 1994

Estimated completion—June 1998

Funding Summary (\$k)

	FY95	FY96	FY97	FY98	Total
Authorized by proposal/additions:	64.5	22.0	12.0	0.0	98.5
Obligated to Date total/contracts:*	64.5/0.0	14.26/10.0	12.0	0.0	
Balance:	0.0	7.74	0.0	0.0	

*NCC8–65 Cooperative Agreement with UAH

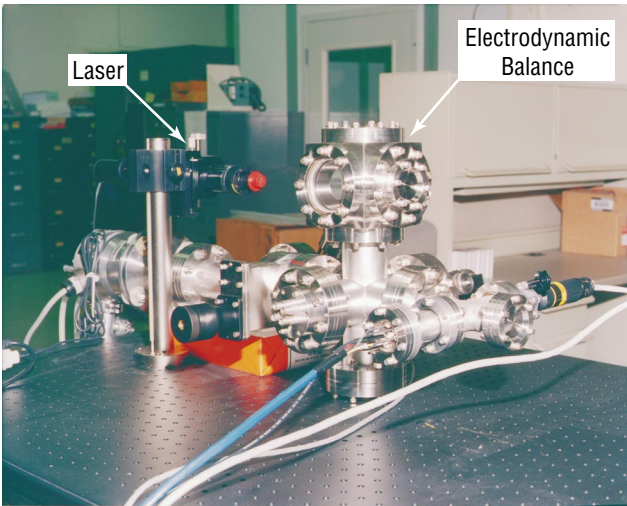


FIGURE 47.—Laboratory apparatus for the dusty plasma experiment. The single dust particle is suspended in an electrodynamic balance located inside the top cube and illuminated with a laser.